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Effect of different levels of organic manures on the growth and yield of garlic

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Abstract: The experiment was carried out at the field laboratory, USDA-Alliums' project, Bangladesh Agricultural University, Mymensingh during rabi season of 2006-2007. Different levels of organic manures viz. cowdung, compost, mustard oil cake, well rotten water hyacinth, bone meal, poultry dropping and ash were used to determine their effects on the growth and yield of garlic. Remarkable variations were observed due to different levels of organic manure on plant height, number of leaves, length and breadth of the longest leaf, number of cloves per bulb, diameter of bulb, yields/plot and ha. Among the organic treatments, the highest dose of mustard oil cake (5 t/ha) was best to influence the yield and yield contributing traits. But, the economic view, the highest net return and the Benefit Cost Ratio (BCR) were received from cow dung followed by second dose of water hyacinth (W_2) and only inorganic fertilizer treatments.

Key words: Manures, different levels, garlic

Introduction

Garlic (*Allium sativum* L.), a herbaceous perennial species belonging to the family Alliaceae (Kurian, 1995), is one of the vital bulbous spices. It is popular all over the world as a valuable spice for different dishes and a rich source of carbohydrate and phosphorus (Rahman *et al*., 2007). Successful garlic cultivation largely depends on the optimum cultural management practices. These include judicious manuring, efficient use of residual soil moisture and mulching. The effect of organic manure on garlic is crucial as it is a heavy feeder. Organic manure improves soil structure through aggregation favourably influencing tillage properties, crusting, water infiltration, moisture retention, aeration, temperature and root penetration. But in Bangladesh, most soils have less than 1.5%, and some even less than 1% organic matter contents (BARC, 2005). The experimental evidences on the effects of different levels of organic manure on garlic are limited under Bangladesh conditions. So, the present work was undertaken to find out the proper amount of organic manures needed for optimal growth and yield of garlic.

Materials and Methods

The experiment was carried out during rabi season of 2006-2007 with a view to studying the effects of different levels of organic manures. The single factor field experiment was laid out in the randomized complete block design with 3 replications. Four levels of the following organic treatments and only inorganic fertilizers were used in this experiment (Table 1). The entire amounts of organic manures were mixed with the soil as per the design of the experimental plot. TSP was used only in the allotted plot of inorganic fertilizers and Urea and MoP were used in the same plot as top dressing in three equal installments at 25, 50 and 75 days after planting of cloves. Ten plants were selected at random from each plot for the collection of data. The tops of garlic plants turned yellow to light brown showing the sign of drying and were ready for harvesting. Data on physio-morphological parameters at 20 days interval after planting as well as on yield were recorded and continued up to the final harvest. The followings data were recorded: plant height (cm), no. of leaves/plant, length of the longest leaf/plant (cm), breadth of the longest leaf/plant (cm), fresh weight of leaves/ plant (g), dry weight of leaves/plant (g), fresh weight of roots/plant (g), dry weight of roots/ plant (g), fresh weight of bulbs/plant (g), dry weight of bulbs/plant (g), diameter of bulbs (cm), no. of cloves/bulb, yield of bulb/plot (kg) and yield of bulb/ha (t). The collected data were statistically analyzed and the mean differences were tested using the Least Significant Difference test (Gomez and Gomez, 1984).

Results and Discussion

Effects of different levels of organic manures on the yield of garlic

Fresh weight of leaves/plant was significantly affected by the different levels of organic manures. The maximum fresh weight of leaves (9.73g) was obtained from the plants grown with the highest dose of mustard oil cake. There was no significant difference among the treatments of M_4, only inorganic, M_3 and C_4. On the other hand, the lowest fresh weight of leaves/plants (4.67g) was obtained from the control (Table 2). Again, the maximum fresh weight of bulb/plants (17.73g) from the highest dose of mustard oil cake (M_4) and the lowest (7.07 g) was obtained from the control (Table 2). The fresh weight of roots increased with the increased levels of organic matter except the highest doses of compost, poultry dropping, processed water hyacinth, bonemeal and ash. Dry weights of leaves and roots were also affected significantly by the different levels of organic manures. The maximum dry weight of leaves (1.67 g) was obtained from M_4 preceded by the inorganic (1.59 g), M_3 (1.45 g) and C_4 (1.42 g) (Table 4). On the contrary, the maximum dry weight of roots/plants (0.20 g) was obtained from the highest dose of cow dung. The minimum (0.27g) in this regard was noted from the control. Bulb diameter was also statistically significant due to different levels of organic manures. The result indicates that the treatment M_4 had the highest (3.40cm) bulb diameter followed by C_4 (3.15cm). Highly significant variation was observed in the number of cloves/ bulb among different levels of organic manures (Table 2). The maximum number of cloves/plant was obtained from M_4 (19.40) followed by C_4 (18.33). On the contrary, the lowest (7.47) was found from the control, which was closely followed in an ascending order by A_4 (8.67) and A_1 (9.60). A wide variation was observed among the different levels of organic matter in respect of yield/plot. Treatment M_4 gave the highest (2.12kg)

yield/plot followed by treatment C_4 (1.85kg) and M_3 (1.92). The lowest yield/plot (0.903 kg) was obtained from the control (Table 2). Again, highest level of mustard oil cake gave the maximum yield (10.57 t/ha) closely followed by C_4 (9.23 t/ha) and M_3 (9.60 t/ha). The lowest yield (4.52 t/ha) was obtained from the control (Table 2). The lower yield was also found in A_1 (4.82 t/ha), A_4 (5.08 t/ha) and A_3 (5.18 t/ha). From the results it was also revealed that growth and yield of garlic showed increasing trend by the application of higher doses of cow dung and mustard oil cake. However, yield was not positively responded by the escalating doses of compost, water hyacinth, poultry droppings and ash.

Table 1. Different doses of organic manure

Manures	Doses (t/ha)			
Cowdung	10 (C_1)	15 (C_2)	20 (C_3)and	25 (C_4)
Compost	10 (Co_1)	15 (Co_2)	20 (Co_3)and	25 (Co_4)
Mustard oil cake	2 (M_1)	3 (M_2)	4 (M_3) and	5 (M_4)
Rotten water hyacinth	15 (W_1)	20 (W_2)	25 (W_3)and	30 (W_4)
Bone meal	2 (B_1)	3 (B_2)	4 (B_3)and	5 (B_4)
Poultry dropping	3 (Pd_1)	4 (Pd_2)	5 (Pd_3)and	6 (Pd_4)
Ash	3 (A_1)	5 (A_2)	7 (A_3)and	9 (A_4)

Table 2. Effects of different levels of organic manures on the growth and yield of garlic

Treatments	Fresh weight(g) of			Dry weight(g) of			Bulb diameter (cm)	No. of cloves/ bulb	yield per plot (kg)	Yield (t/ha
	leaves per plant	bulb	roots per plant	leaves per plant	bulb	roots per plant				
C_1	6.23	9.47	0.40	1.04	2.52	0.13	2.56	11.27	1.12	5.60
C_2	7.20	10.53	0.43	1.12	3.01	0.15	2.97	13.47	1.26	6.30
C_3	7.27	12.13	0.48	1.30	3.32	0.17	3.15	16.80	1.53	7.65
C_4	8.03	14.60	0.58	1.42	4.06	0.20	3.28	18.33	1.85	9.23
Co_1	6.97	10.30	0.39	1.36	3.04	0.12	2.89	11.40	1.24	6.22
Co_2	7.93	11.90	0.41	1.24	2.81	0.14	3.05	16.13	1.45	7.23
Co_3	7.53	11.47	0.44	1.29	3.10	0.14	3.07	13.47	1.38	6.90
Co_4	6.73	9.33	0.39	1.14	2.42	0.11	2.75	12.47	1.11	5.55
M_1	7.47	11.47	0.45	1.25	3.10	0.13	3.01	14.53	1.31	6.57
M_2	7.80	13.70	0.50	1.31	3.46	0.16	3.20	16.80	1.67	8.37
M_3	8.60	14.97	0.57	1.45	3.13	0.19	3.25	18.33	1.92	9.60
M_4	9.73	17.73	0.56	1.67	3.93	0.19	3.40	19.40	2.12	10.57
Pd_1	6.67	10.60	0.39	1.09	2.46	0.12	2.89	11.13	1.26	6.32
Pd_2	7.10	11.07	0.42	1.23	2.97	0.14	3.01	13.07	1.31	6.57
Pd_3	6.30	10.23	0.39	1.07	2.98	0.12	2.71	11.73	1.22	6.10
Pd_4	6.10	9.90	0.35	1.04	2.59	0.10	2.69	11.07	1.16	5.80
W_1	7.17	10.10	0.37	1.14	2.87	0.11	2.75	11.27	1.21	6.05
W_2	7.60	11.77	0.43	1.23	2.92	0.12	2.98	15.13	1.73	8.67
W_3	7.33	10.77	0.42	1.22	3.02	0.14	2.98	11.80	1.34	6.68
W_4	5.80	9.17	0.35	1.00	2.32	0.11	2.52	11.20	1.13	5.63
B_1	7.00	10.93	0.43	1.14	3.00	0.14	2.62	12.47	1.28	6.52
B_2	7.60	12.03	0.47	1.30	3.04	0.16	3.13	13.13	1.49	7.43
B_3	7.80	12.47	0.52	1.27	2.77	0.17	3.09	16.27	1.59	7.95
B_4	6.60	9.97	0.38	1.12	2.49	0.11	2.65	11.87	1.22	6.10
A_1	5.60	7.73	0.31	0.94	2.42	0.10	2.12	9.60	0.96	4.82
A_2	6.33	9.53	0.33	1.07	2.79	0.11	2.73	10.67	1.09	5.45
A_3	6.20	8.73	0.30	1.06	2.92	0.10	2.71	10.00	1.04	5.18
A_4	5.73	8.67	0.28	0.95	2.44	0.10	2.51	8.67	1.02	5.08
Ino	9.27	11.67	0.55	1.59	2.98	0.18	2.83	16.40	1.47	7.35
Control	4.67	7.07	0.27	0.80	1.80	0.08	2.07	7.47	0.90	4.52
LSD 5%	1.32	2.24	0.05	0.22	0.54	0.02	0.12	1.88	0.19	0.91
LSD 1%	1.76	2.98	0.07	0.29	0.72	0.03	0.15	2.50	0.25	1.21
Level of sign.	**	**	**	**	**	**	**	**	**	**

** Significant at 1% level, C = Cowdung, W = Water hyacinth, Co = Compost, B = Bone meal, M = Mustard oil cake, A = Ash, Pd = Poultry dropping, Ino = Inorganic fertilizers only

Table 3. Correlation co-efficient between yield and yield contributing traits of garlic

Characters	Plant height (cm) at 90 DAP	Bulb diameter (cm)	Fresh weight of bulb (g)	Fresh weight of leaves/ plant (g)	Dry weight of bulb (g)	Dry weight of leaves/ plant (g)	No. of cloves/ bulb	Yield/ plot (kg)
Number of leaves/ plant at 90 DAP	0.450**	0.777**	0.726**	0.684**	0.617**	0.708**	0.742**	0.767**
Plant height (cm) at 90 DAP		0.483**	0.481**	0.454**	**0.352****	0.451**	0.525**	0.511**
Bulb diameter (cm)			0.813**	0.721**	0.714**	00.722**	0.792**	0.832**
Fresh weight of bulb (g)				0.771**	0.625**	0.757**	0.753**	**0.943****
Fresh weight of leaves/plant (g)					0.504**	0.893**	0.678**	0.756**
Dry weight of bulb (g)						0.585**	0.633**	0.658**
Dry weight of leaves/plant (g)							0.668**	0.749**
No. of cloves/bulb								0.840**

** Significant at the 0.01 level.

Table 4. Path coefficient analysis showing the direct (bold) and indirect effects of different characters on the yield of garlic

Characters	No. of leaves/ plant at 90DAP	Plant height at 90 DAP	Bulb diameter (cm)	Fresh wt. of bulb (g)	Fresh wt. of leaves/ plant (g)	Dry wt. of bulb (g)	Dry wt. of leaves/ plant (g)	No. of cloves/ bulb	Yield /plot (kg)
Number of leaves/plant at 90 DAP	**0.055**	0.004	0.008	0.500	-0.011	0.015	0.002	0.194	0.767
Plant height (cm) at 90 DAP	0.025	**0.010**	0.005	0.331	-0.007	0.009	0.001	0.137	0.511
Bulb diameter (cm)	0.043	0.005	**0.010**	0.560	-0.012	0.017	0.002	0.207	0.832
Fresh weight of bulb (g)	0.040	0.005	0.008	**0.688**	-0.012	0.015	0.002	0.197	0.943
Fresh weight of leaves/plant (g)	0.038	0.005	0.007	0.531	**-0. 016**	0.012	0.002	0.177	0.756
Dry weight of bulb (g)	0.034	0.004	0.007	0.430	-0.008	**0.024**	0.002	0.165	0.658
Dry weight of leaves/plant (g)	0.039	0.005	0.007	0.521	-0.014	0.014	**0.003**	0.174	.749
No. of cloves/bulb	0.041	0.006	0.008	0.518	-0.011	0.015	0.002	**0.261**	.840**

Residual effect 0.264

Correlation Matrix: Correlation studies were made in order to find out the relationships among yield and yield contributing traits. From the correlation matrix (Table 3) it would be clear that all the studied parameters were significantly associated among themselves. It was observed that plant height and number of leaves/plant at 90 days after planting showed significant positive correlations with the bulb diameter, fresh weight of bulb, dry weight of bulb and leaves, no. of cloves/bulb and the yield/plot. The results also revealed that all the yield contributing traits viz. diameter of bulb, fresh weight of bulb and leave; dry weight of bulb and leaves; no. of cloves had affirmative associations with the bulb yield.

Path coefficient analysis: The path coefficient analysis (Table 4) through coefficient revealed that plant height at 90 DAP, no. of leaves/plant at 90 DAP, fresh weights of bulbs, dry weight of bulb and leaves, bulb diameter and number of cloves/plant showed positive direct effects on the yield. From the result it was also clear that fresh weight of bulb showed a strong positive effect (0.688) on the yield. On the other hand, fresh weight of leaves/plant exhibited negative direct effects on the yield (Table 4). The residual effect of path analysis was 0.264, which exposed that there were treatment variabilities on the selected nine traits of garlic. This residual effect towards yield may be due to reasons, viz. character not studied here and the sampling errors.

Economic analysis: The results obtained from the economic analysis indicated that the gross return and the net return differed under varying levels of organic sources. The total cost of production was highest (213487.50 Tk./ha) in the utmost level of bone meal (B4) followed by the maximum dose of mustard oil cake (216609.50Tk /ha). On the contrary, the highest gross return was noted from the topmost level of mustard oil cake (M_4). It was also found that highest net return was in the (150382.50Tk./ha) top level of cow dung (C_4). But, unhelpful net return (-30487.50 Tk./ha) was received from the highest level of bone meal (B_4). Higher net return was also observed from the second dose of water hyacinth (W_2) and only inorganic fertilizer treatment (Table 5). Considering the benefit cost ratio (BCR), the maximum range of cow dung (M_4) had the higher value (2.19) than the rest treatments.

Discussion

From the results it was also revealed that the growth and yield of garlic showed increasing trend due to the application of higher doses of cow dung and mustard oil cake. Nevertheless, the yield was not positively responded by the rising doses of compost, water hyacinth, poultry droppings and ash. The treatment M_4 gave the highest results in case of all the mentioned parameters except fresh and dry weights of roots, and the dry weight of bulb. So, mustard oil cake is a good source of organic manure in Bangladesh. But from economic view, it was unprofitable for the commercial production of garlic. Cow dung also showed significant effects on all the mentioned parameters at different DAP. Moreover, the highest net return and the Benefit Cost Ratio (BCR) received from cow dung were highest followed by second dose of water hyacinth (W_2) and only inorganic fertilizer treatment. Therefore, cow dung and water hyacinth appeared important resources in sustainable and organic crop production. Organic manure enhanced the physical conditions of the soil, resulting availability micro nutrients which help the plant to establish easily in the field and uptake nutrient slowly at

the tender stage of the plants. Moreover, the shallow rooted crops are more sensitive to water stress. Their roots do not have the access to reserved underground soil water as deep-rooted crops do. Organic matter increases the water holding capacity and this help roots to grow more efficiently along with luxurious vegetative growth leading to good production. Therefore, appropriate amount of organic matter maximizes growth and ensures all physiological activities leading to higher yield. Asiegbu *et al*. (1984) reported that bulb diameter and the percentage of grade I bulbs increased with the escalating application of FYM. They also found that onion yield was maximum with 20 t FYM/ha. These results partially agree with Dixit (1994) who stated that higher yield was also obtained with the higher rate of FYM. Pereira *et al*. (1987) suggested that 20 tons compost/ha was appreciable for the higher yield of garlic.

Table 5. Cost of garlic production in respect of different levels of organic manures for one hectare land

Treatments	Yield (t/ha)	Gross return (Tk./ha)	Total cost of production (Tk./ha)	Net return (Tk./ha)	BCR
C_1	5.60	168000	113472.00	54528.00	1.48
C_2	6.30	189000	117820.50	71179.50	1.60
C_3	7.65	229500	122169.00	107331.00	1.88
C_4	9.23	276900	126517.50	150382.50	2.19
Co_1	6.22	186600	112691.50	73908.50	1.66
Co_2	7.23	216900	118433.80	98466.20	1.83
Co_3	6.90	207000	124176.00	82824.00	1.67
Co_4	5.55	166500	129918.30	36581.70	1.28
M_1	6.57	197100	147368.00	49732.00	1.34
M_2	8.37	251100	170448.50	80651.50	1.47
M_3	9.60	288000	193529.00	94471.00	1.49
M_4	10.57	317100	216609.50	100490.50	1.46
Pd_1	6.32	189600	108454.50	81145.50	1.75
Pd_2	6.57	197100	110350.00	86750.00	1.79
Pd_3	6.10	183000	112245.50	70754.50	1.63
Pd_4	5.80	174000	114141.00	59859.00	1.52
W_1	6.05	181500	117653.30	63846.70	1.54
W_2	8.67	260100	123395.50	136704.50	2.11
W_3	6.68	200400	129137.80	71262.20	1.55
W_4	5.63	168900	134880.00	34020.00	1.25
B_1	6.52	195600	146587.50	49012.50	1.33
B_2	7.43	222900	168887.50	54012.50	1.32
B_3	7.95	238500	191187.50	47312.50	1.25
B_4	6.10	183000	213487.50	-30487.50	0.86
A_1	4.82	144600	104440.50	40159.50	1.38
A_2	5.45	163500	106336.00	57164.00	1.54
A_3	5.18	155400	108231.50	47168.50	1.44
A_4	5.08	152400	110127.00	42273.00	1.38
Ino	7.35	220500	116817.00	103683.00	1.89
Control	4.52	135600	101207.00	34393.00	1.34

** Significant at 1% level, C = Cowdung, W = Water hyacinth, Co = Compost, B = Bone meal, M = Mustard oil cake, A = Ash, Pd = Poultry dropping, Ino = Inorganic fertilizers only

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